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(54) METHOD OF MANUFACTURING A DIAPHRAGM FOR A TRANSDUCER

(71) We, PHILIPS ELECTRONIC AND ASSOCIATED INDUSTRIES LIMITED, of Abacus House, 33 Gutter Lane, London, E.C.2, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a method of manufacturing a diaphragm for an electroacoustic transducer, which diaphragm is made from a synthetic material in a die and in the moulding operation is provided with a domed centre portion and a surrounding edge portion, two substantially parallel arranged strip-shaped conductors being provided which extend from one part of the edge region to an adjacent part thereof via the domed centre portion.

British Patent Specification No. 1,229,465 describes such a method in which in order to form a moving coil loudspeaker diaphragm an amount of a thermo-setting synthetic resin is introduced as a powder into a die. The electrical connections between the loudspeaker coil and the strip-shaped conductors are established in the die in a single operation, resulting in a robust unit.

In view of fracture phenomena this method has been found to be of particular advantage for manufacturing comparatively heavy diaphragms, in particular diaphragms for horn loudspeakers.

It has been found, however, that in view of the fragile construction of microphone diaphragms, especially miniature diaphragms, this method cannot be used in large-scale manufacture of such diaphragms.

According to the invention, there is provided a method of manufacturing a diaphragm for an electroacoustic transducer, which diaphragm is made from a synthetic material in a die and in the moulding operation is provided with a domed centre portion and a surrounding edge region, whilst two substantially parallel arranged strip-shaped conductors have been provided which extend from one part of the edge region to a substantially opposite part of this region via the domed centre portion, wherein manufacture starts from a tape-shaped foil of a synthetic material which has previously been provided with the two parallel arranged conductors and is fed to the die, the foil being of sufficient width as to extend completely across the die and the foil being placed so as to extend completely across the die, the diaphragm being subsequently formed in the die in a single moulding operation.

The tape-shaped foil is fed to the die from a roll. During the moulding operation the required shape of the diaphragm is formed, which is then punched from the foil. The moving coil is glued to the edge formed on the domed centre portion in a separate operation. The coil end connections are soldered to the strip-shaped conductors at the inner surface of this domed centre portion.

However, the resulting diaphragm, like the diaphragm made by the aforesaid known method, has the property of being particularly resistant to fracture phenomena which is due to the continuously varying forces which are transmitted by the vibrating diaphragm to the strip-shaped conductors.

The method according to this invention provides a transducer which is provided with a diaphragm made of a synthetic material, has a domed centre portion and a surrounding edge region and is also provided with two substantially parallel arranged strip-shaped conductors which extend from one part of the edge region to a more or less opposite part thereof via the domed centre portion.

The two parallel conductors may be provided with branches. To these branches there may be soldered, in parallel with the moving coil, a "humbucking" coil which serves to neutralize the influence of external electro-magnetic fields.

The conductor may be applied to the foil by deposition from vapour or by electro-

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chemical means. Advantageously the conductors are subsequently tinned, thus facilitating the soldering operation.

Particularly advantageous is an embodiment of the transducer according to this invention in which the diaphragm is provided with a projecting part of the same foil, the parallel conductors extending into this part. This part has the function of enabling the electrical connections to be made within the housing of the transducer.

Embodiments of this invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a cross-sectional view of a die for use in the method according to this invention,

Figure 2 is a plan view thereof,

Figure 3 shows the product made in this die,

Figure 4 shows the same product provided with a moving coil,

Figure 5 shows a detail thereof,

Figure 6 is a plan view of the product shown in Figure 3,

Figure 7 is an alternative embodiment thereof, and

Figure 8 shows a diaphragm according to this invention having a flap-shaped extension.

The die shown diagrammatically in Figure 1 comprises an upper half 1 and a lower half 2 which are relatively movable. The two halves define a space 3 for receiving a foil 4 of a synthetic material, for example a polyester film as "Mylar" (Registered Trade Mark), on which two conductive strips 5 and 6 have been provided. These conductive strips are arranged parallel to one another and comprise layers of copper from 5 to 15μm thick which have meen tinned. The copper layers are deposited on the foil by electrochemical means. The foil is fed to the die from a roll 7. The upper die half 1 is made of hard rubber. The foil is shaped into the required diaphragm form by the moulding operation. The upper die half 1 is surrounded by an annular punch 8 which punches the diaphragm *10* from the foil after the moulding operation.

The product, a diaphragm for a small type of microphone, is shown in Figure 3 and comprises a domed centre portion 11 the edge 12 of which is thickened. The edge 12 of the diaphragm is provided with corrugations 13. A moving coil 14 (see Figure 4) is glued to the thickened edge 12. End connections 15 of the moving coil are connected at the inner surface of the domed centre portion 11 to the strip-shaped conductors 4 and 5 by soldering. This is shown in more detail in Figure 5.

Figure 6 is a plan view of a diaphragm manufactured by a method described. The Figure shows that the copper conductors 5 and 6 extend from one part of the edge region to a substantially opposite part of the edge region via the domed centre portion 11.

Figure 7 shows such a diaphragm provided with additional strip-shaped conductors 20 which are connected as branches to conductors 5 and 6. The ends of a humbucking coil (not shown) may be connected to these branches.

Figure 8 shows a diaphragm having a flap-shaped projecting part 21. This projecting part is shaped so that the conductors 5 and 6 extend over it in its direction of length. When the diaphragm is mounted, the projecting part 21 is accommodated in the microphone housing.

WHAT WE CLAIM IS:—

1. A method of manufacturing a diaphragm for an electro-acoustic transducer, which diaphragm is made from a synthetic material in a die and in the moulding operation is provided with a domed centre portion and a surrounding edge region, whilst two substantially parallel arranged strip-shaped conductors have been provided which extend from one part of the edge region to a substantially opposite part of this region via the domed centre portion, wherein manufacture starts from a tape-shaped foil of a synthetic material which has previously been provided with the two parallel arranged conductors and is fed to the die, the foil being of sufficient width as to extend completely across the die and the foil being placed as to extend completely across the die, the diaphragm being subsequently formed in the die in a single moulding operation.

2. A transducer provided with a diaphragm made of a synthetic material having a domed centre portion and a surrounding edge region and provided with two substantially parallel arranged strip-shaped conductors which extend from one part of the edge region to a substantially opposite part thereof via the domed centre portion, wherein the diaphragm is made by the method claimed in the preceding claim.

3. A transducer as claimed in Claim 2, wherein each of the conductors has at least one branch.

4. A transducer as claimed in Claim 2 or Claim 3, wherein the conductors have been provided on the synthetic material of the diaphragm by deposition from the vapour phase.

5. A transducer as claimed in Claim 2 or Claim 3, wherein the conductors have been provided electro-chemically on the synthetic material of the diaphragm.

6. A transducer as claimed in Claim 4 or Claim 5, wherein the conductors are provided on the surface of the diaphragm which provides the inner surface of the dome and are subsequently tinned.

7. A transducer as claimed in any of the preceding Claims, wherein the diaphragm is provided with a projecting part of the same foil into which the parallel arranged conductors extend.

8. An electro-acoustic transducer substantially as herein described with reference to the accompanying drawings.

9. A microphone including a transducer as claimed in any one of Claims 2 to 8.

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1381376 COMPLETE SPECIFICATION
2 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheet 1

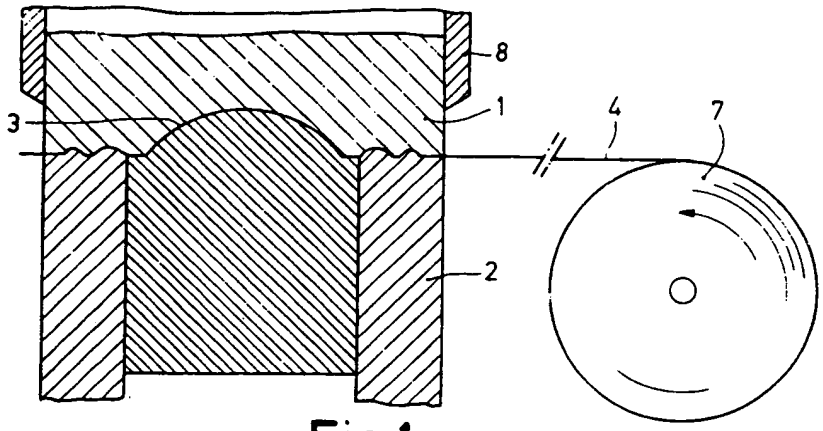

Fig.1

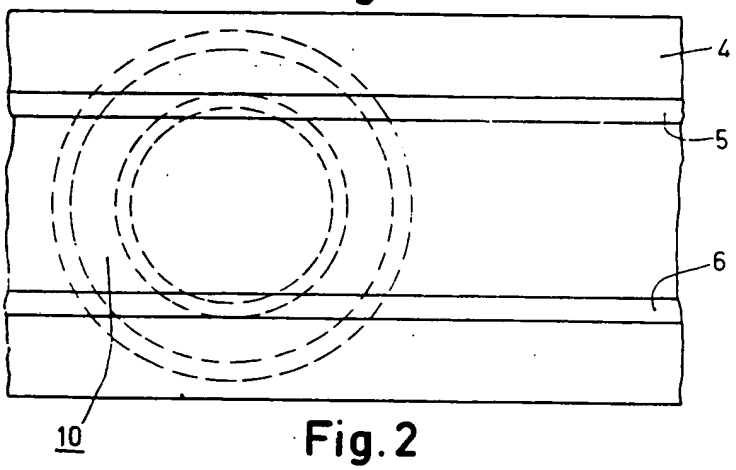

Fig.2

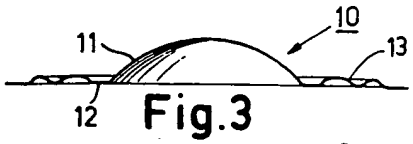

Fig.3

Fig.4

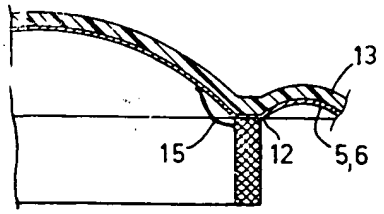

Fig.5

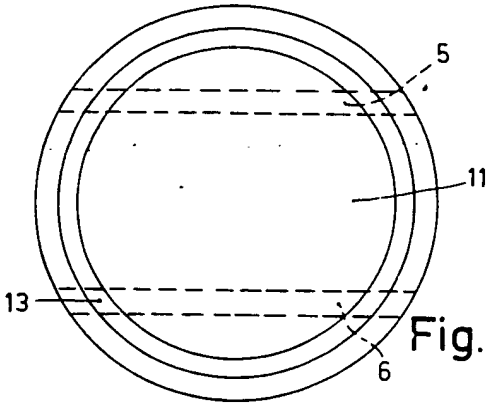

Fig. 6

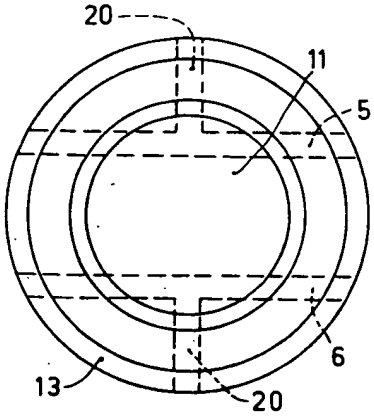

Fig.7

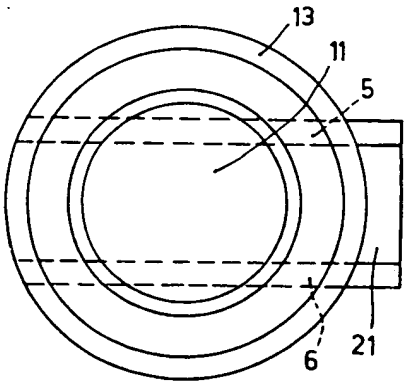

Fig.8